CONTRIBUTIONS TO PALÆONTOLOGY

VI

PLEISTOCENE MAMMALIAN FAUNA FROM THE CARPINTERIA ASPHALT

By Robert W. Wilson

[Preprinted from Carnegie Institution of Washington Publication No. 440, pages 59 to 76, November, 1933]

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THE PLEISTOCENE MAMMALIAN FAUNA FROM THE CARPINTERIA ASPHALT

INTRODUCTION

Plant and animal remains were first discovered in the Carpinteria asphalt deposits on the Higgins Ranch near the town of Carpinteria early in 1927.[1] A preliminary announcement of the occurrence was published by Hoffman, Stock and Chaney.[2] Since then more detailed work carried on at the locality has furnished additional and larger collections of bird and mammal material. While the bird assemblage has been determined by Loye Miller[3] and by Alden Miller,[4] no very complete list of the mammals is as yet available. The present study embodies a critical determination of the various mammalian types occurring in the fauna with a view to establishing evidence of value in an interpretation of the age relationships of the deposits and of the environmental conditions under which the mammalian fauna existed. The problem was suggested by Doctor Chester Stock of the California Institute of Technology, to whom the author is indebted for guidance during the course of the investigation and for criticism of the manuscript.

The author also wishes to thank the staff of the late Mr. Donald R. Dickey at the California Institute of Technology for courtesy in permitting use of their collections of Recent mammals.

CHARACTER AND AGE OF FAUNA

The mammalian material from Carpinteria is of very fragmentary character. Due to the incomplete preservation, specific identification of the remains was always difficult and for most of the types only a generic determination was possible. Moreover, a satisfactory determination of the material was not always reached because of the immaturity of a large number of individuals entombed in the tar. While the rodent assemblage is not characterized particularly by immature animals, 50 per cent or more of the remaining material in the collection represents animals which range in age from juvenile to sub-adult. Among the larger mammals, as for example the dogs, deer and horses, this aspect of the fauna is carried to such an extreme that practically no remains of adults are found. The following is a list of mammals occurring in the Carpinteria asphalt.

[1] Evidently the first notice of wood impregnated by bitumen occurring in deposits exposed on the Higgins Ranch was made by H. C. Ford in Bull. Santa Barbara Soc. Nat. Hist., vol. I, No. 2, 11, 1890.

[2] Science, vol. 66, 155–157, 1927.

[3] Loye Miller, Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 20, 361–374, 1931.

[4] A. H. Miller, Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 21, 169–194, 1932.

Insectivora
- Sorex cf. ornatus Merriam
- Sorex cf. trowbridgii Baird

Carnivora
- Mustela species
- Spilogale phenax Merriam
- Mephitis occidentalis Baird
- Taxidea species
- Urocyon near cinereoargenteus (Schreber)
- Canis species
- Ænocyon near dirus (Leidy)
- Felis probably atrox Leidy
- Lynx species

Artiodactyla
- Camelops? cf. hesternus (Leidy)
- Odocoileus species
- Bison? species

Rodentia
- Eutamius species
- Sciurus species
- Thomomys near bottæ (Eydoux and Gervais)
- Perognathus species
- Dipodomys species
- Onychomys? species
- Peromyscus species
- Neotoma species
- Microtus californicus (Peale)

Lagomorpha
- Lepus near californicus Gray
- Sylvilagus bachmani (Waterhouse)

Perissodactyla
- Equus near occidentalis Leidy

The presence of many forms closely similar in structural details to living species now occupying the region of Carpinteria suggests an age of the fauna not older than Quaternary. The mammalian assemblage includes only four extinct types, namely, *Ænocyon* near *dirus*, *Felis* probably *atrox*, *Camelops?* cf. *hesternus* and *Equus* near *occidentalis*. *Sorex* cf. *trowbridgii*, *Onychomys?* species, and *Bison?* species, do not now range in the area about the brea deposits. The remaining mammals in the fauna, so far as they can be determined, do not differ from those existing in the region at the present time. Thus the constituency of the Carpinteria assemblage offers no salient facts mitigating against a late Pleistocene age.

Comparison with the mammalian fauna of Rancho La Brea does not satisfactorily establish the age relationship of the Carpinteria assemblage with reference to the former. The occurrence at Carpinteria of a few forms which do not appear at Rancho La Brea may be due to a difference in ecologic conditions. The presence at both localities of a number of Recent genera sheds no light on the respective ages of the deposits. Thus some of the principal evidence of value in determining the time relationships of the two faunas is presented by the absence at Carpinteria of many of the extinct forms that occur commonly at Rancho La Brea. It should be emphasized, however, that this is negative evidence, doubtless magnified somewhat by the difference in ecologic conditions prevailing at the two localities. On the other hand the presence of species evidently related to *Ænocyon dirus*, *Felis atrox*, *Camelops hesternus* and *Equus occidentalis* at Carpinteria may be regarded as evidence suggesting that the fauna was contemporaneous with the Rancho La Brea assemblage. The conclusion may be drawn from these considerations that the Carpinteria fauna is certainly not older than the assemblage from Rancho La Brea, and may be younger.

ECOLOGIC CONSIDERATIONS

In determining the ecologic aspects of the Carpinteria occurrence as inferred from the mammalian fauna, the presence of shrews is significant for, according to Hartley H. T. Jackson,[1] these insectivores characteristically inhabit moist places with abundant vegetation, such as stream banks, meadows and damp woods, especially of coniferous trees. *Sorex trowbridgii* offers a slight deviation, for although found at the present time in the habitat usually occupied by the long-tailed shrews, it shows a marked tendency to inhabit drier woods. Thus the occurrence of shrews in the Carpinteria asphalt furnishes an item of evidence in support of the forest environment postulated from a study of the avifauna and of the flora.

Rodents are in general sensitive indicators of climate and environment. While the fragmentary state of preservation of the material makes an interpretation of the ecologic conditions difficult, the evidence presented by these mammals may serve to check, and perhaps amplify, conclusions drawn from studies of the birds, plants and other mammals.

Presence of the chipmunk (*Eutamius*) and of the tree squirrel (*Sciurus*) suggests rather strongly a region at least partly forested, and is thus evidence again substantiating conclusions derived from a study of the avifauna and of the flora. The list of rodents and lagomorphs moreover indicates a mingling of semi-arid and sylvan types. Associated with *Sciurus* and *Eutamius* are *Dipodomys* and *Onychomys?*. Doctor Loye Miller[2] records evidence for the recognition of two ecologic stages during the period of occurrence of the Carpinteria avifauna, but does not regard this difference as necessarily due to a major time interval. Doctor Miller believes both stages show a definite sylvan environment with one faunule exhibiting this character more strongly than the other. This view does not satisfactorily explain the relationships found in the rodent fauna. The intermingling of semi-arid and sylvan forms in the same deposits may, however, be accounted for if we assume that the accumulation of the material occurred at a locality situated near the edge of an existing forest.

When compared with the Pleistocene rodent fauna from Rancho La Brea, the Carpinteria assemblage exhibits some marked differences. Presence of the chipmunk and tree squirrel at Carpinteria and their absence at Rancho La Brea support the evidence furnished by the floras and avifaunas that the region was, unlike that in the vicinity of Rancho La Brea, at least partly forested. Further, the relative abundance of individuals representing different genera offers some contrasting features. At Rancho La Brea gophers of the genus *Thomomys* far exceed all other forms in numerical representation. Among the

[1] Hartley H. T. Jackson, U. S. Dept. Agriculture, North American Fauna No. 51, 3–4, 1928.
[2] Loye Miller, *ibid.*, 364–365, 1931.

rodents and lagomorphs found at the latter locality those relatively abundant in the fauna are the kangaroo-rat *Dipodomys*, the pocket-mouse *Perognathus*, and the cottontail *Sylvilagus audubonii*, while those less abundant include the meadow-mouse *Microtus*, the white-footed mouse or deer-mouse *Peromyscus*, and the ground-squirrel *Otospermophilus*. Rare forms are represented by the harvest-mouse *Reithrodontomys*, the jack-rabbit *Lepus*, the brush-rabbit *Sylvilagus bachmani*, the wood-rat *Neotoma*, and the grasshopper-mouse *Onychomys*. In the Carpinteria asphalt, *Peromyscus* occurs as the most abundant form. The deer-mice are represented by more than twice the number of individuals recorded for the type nearest in abundance. With decreasing representation, but still abundant, occur the genera *Dipodomys*, *Thomomys* and *Microtus*. *Eutamius* and *Sylvilagus bachmani* are relatively common while *Perognathus*, *Sciurus*, *Onychomys?*, *Neotoma* and *Lepus* are rare. The order of abundance may or may not possess significance as a reflection of differences in ecologic conditions presented at the two localities. It is well to remember that the susceptibility of certain forms to capture by the peculiar agencies operative in tar seep accumulations may be responsible for at least some of the difference in numerical representation. The presence of a relatively large number of individuals of the genus *Dipodomys* is interesting, since this form occurs typically on arid and semi-arid plains of the Californian region at the present time. Assuming that the fundamental habits and habitat of the kangaroo-rats have undergone no great change since late Pleistocene time, the occurrence of these creatures at Carpinteria furnish some of the more striking evidence in support of the view that the forest cover in the region of the asphalt accumulation was broken by areas of sparser vegetation.

A minimum number of 130 individuals is represented in the rodent and lagomorph fauna. Approximate percentages of individuals for particular genera are as follows:

Sciuridæ
- Eutamius, 5 per cent
- Sciurus, 1 per cent

Geomyidæ
- Thomomys, 16 per cent

Heteromyidæ
- Perognathus, 2 per cent
- Dipodomys, 17 per cent

Cricetidæ
- Onychomys?, 1 per cent
- Peromyscus, 39 per cent
- Neotoma, 1 per cent
- Microtus, 12 per cent

Leporidæ
- Lepus, 1 per cent
- Sylvilagus, 5 per cent

Presence of the larger mammals likewise suggests an environment not exclusively sylvan in character. While a number of these forms may have lived under forest conditions, *Equus*, *Bison* and *Camelops* appear to reflect the influence of more open country and of a semi-arid climate.

Thus a survey of the fauna reveals the presence of certain mammals whose inferred habits and habitats substantiate the ecologic conditions at the Carpinteria locality postulated from a study of the plants and avifauna found in the asphalt. In addition to these are other mammals that normally inhabit semi-arid regions. Presence of the latter appears to reflect an influence which is not so apparent from the constitution of the plant or avian assemblage. Proximity of the locality of occurrence to a forest border with perhaps fluctuations in the amount and extent of the plant and tree cover during the period of accumulation may account for this association of mammals.

Furthermore, the presence of many young and immature individuals among the mammals suggests likewise (1) a particularly great susceptibility to entombment in brea deposits, in which respect the Carpinteria fauna may be likened to the Rancho La Brea assemblage, and (or) (2) opportunities for shelter and protection afforded by tree and plant cover.

DESCRIPTION OF FAUNA

INSECTIVORA

Sorex cf. ornatus Merriam

Remains of this long-tailed shrew are limited to two right rami, one with complete dentition excepting the lower canine, No. 32.1 Santa Barbara Museum Pale. Coll., the other without teeth. As far as can be determined, these rami represent the same species.

Size and geographic distribution of species inhabiting western California are of particular importance in the attempt to reach a determination of this insectivore. Shrews do not exhibit much individual variation in size, nor is there a great sex difference in this character. No species other than *S. ornatus* is now found in the Carpinteria region, and the fossil specimens agree well in size and in tooth structure with this form. Certain subspecies of *S. obscurus* and *S. vagrans* are similar in size to *S. ornatus*. While not occurring in the Carpinteria region at the present time, the distribution of these types is such that their range during the Pleistocene may have included also this area. Definite specific determination must await, therefore, the acquisition of more complete material.

Sorex cf. trowbridgii Baird

A single specimen of this type is available, a portion of maxillary bearing $P\underline{4}$ to $M\underline{2}$, No. 32.2 Santa Barbara Mus. Pale. Coll. The fossil specimen corresponds in size and in tooth structure to *Sorex trowbridgii montereyensis* and evidently differs distinctly from *S. ornatus* in larger size.

The Carpinteria specimen is smaller than *S. pacificus sonomæ* and evidently larger than *S. vagrans halicœtes*. The latter subspecies is restricted to a limited area immediately south of San Francisco Bay. The Carpinteria form presumably is also larger than *S. obscurus obscurus* from the Sierran region and *S. o. parvidens* from the San Bernardino Mountains. No direct comparisons were made, however, with the three last-mentioned forms.

Sorex t. montereyensis does not at the present time extend southward into the Carpinteria region, although it is found in Santa Barbara County and may have had an even greater range in the Pleistocene.

CARNIVORA

Mustela species

Only one specimen of a weasel has thus far been obtained. This is a skull fragment representing the occipital segment, tympanic bullæ, and portions of the parietal, No. 1275, Calif. Inst. Tech. Coll. Vert. Pale.

In size No. 1275 falls within the range of the California weasel *Mustela xanthogenys*. The tympanic bullæ do not seem to be so truncate anteriorly as in typical *M. xanthogenys*. However, according to C. Hart Merriam[1] the tympanic bullæ in *M. xanthogenys* are usually truncate anteriorly, a statement implying that variations exist in this character.

Spilogale phenax Merriam

Remains of the spotted skunk are distinctly less common in the collections than those of the striped skunk. The material consists of two skulls, Nos. 1276 and 1277, and a ramus, No. 1278, Calif. Inst. Tech. Coll. Vert. Pale. Specimen No. 1276 is a nearly complete adult skull lacking only the dentition anterior to P3 on each side. No. 1276 may represent a female individual. Specimen No. 1277 is an incomplete skull of an adult, possibly female, which is fractured across the postorbital processes and with the occipital region missing and zygomatic arches incomplete. Right M1 is missing as is the dentition anterior to P3 on either side. Specimen No. 1278 is a rather large, perfect left ramus with M1 to C in place. The two skulls do not differ essentially from each other except in minor details and these may be regarded as manifestations of individual variation.

Intergrades between subspecific types of skunks whose ranges extend well away from the Santa Barbara area are known to occur in this region at the present time. Assuming that the zone of intergradation has undergone no profound shift since the period of occupancy of the Carpinteria Pleistocene fauna, one might expect to find *Spilogale* in the latter assemblage exhibiting likewise the characters of intergrades. If on the other hand the Monterey forest assemblage during Pleistocene time extended southward into the Santa Barbara region, a representation of the northern skunk (*Spilogale phenax phenax*) in the asphalt appears entirely probable. It is also conceivable that the race, *Spilogale phenax amphialus*, inhabiting the Channel Islands, might represent in at least some of its subspecific characters the type found in the Carpinteria Pleistocene.

Although these considerations hold much of interest in the identification of fossil spotted skunks from the asphalt, definite assignment of the latter to any one of the living subspecies can hardly be countenanced in the absence of larger series of specimens. Moreover, the fossil material, as best exemplified in No. 1276, possesses a combination of characters which makes it difficult to place in any one of the three Californian subspecies, namely *phenax*, *microrhina* and *amphialus*. If specimen No. 1276 represents a female, then this difficulty is certainly not diminished. If on the other hand No. 1276 is a male the specimen resembles more the southern form, *S. p. microrhina*, than either *phenax* or *amphialus*.

Perforation of the skull in the region of the postorbital constriction, due to the work of parasitic larvæ and frequently found in the Recent *Spilogale*, is present also in the fossil, No. 1276.

[1] C. Hart Merriam, U. S. Dept. Agric., North American Fauna 11, 25, 1896.

Mephitis occidentalis Baird

Remains of the striped skunk are numerous in the Carpinteria deposits. The material includes fragments of skulls and more or less complete lower jaws as well as two fairly complete skulls, No. 32.3 Santa Barbara Mus. Pale. Coll., and No. 1279, Calif. Inst. Tech. Coll. Vert. Pale. No. 32.3 S.B.M. is in a nearly perfect state of preservation but lacks P2 to I2 on the right side and all of the teeth anterior to P4 on the left side. The specimen apparently represents a fully adult, but not old, female. Specimen No. 1279 is a fairly complete skull of an adult male. I1 to C are missing on the left side, as are the teeth anterior to P3 on the right side. The skull is fractured transversely across the postorbital constriction and part of the zygomatic arch is broken away.

A study of the fossils indicates that the material is evidently to be placed in the *occidentalis* group. Certain characters which are exhibited tend to separate the Carpinteria form from *Mephitis occidentalis occidentalis* and *M. o. holzneri*.

Specimen No. 32.3 Santa Barbara Mus. when compared with female skulls of *M. o. occidentalis* available for comparison shows the following differences: foramen magnum more elliptical; auditory and mastoid bullæ more inflated; and M1 and P4 weaker. The most striking difference is seen perhaps in the shortened anteroposterior diameter of M1. This tooth in Recent specimens is heavier and more nearly square.

M. o. holzneri in contrast to *M. o. occidentalis* is characterized principally and perhaps only by smaller size throughout. This is shown by the measurements given by Howell[1] as well as by measurements of specimens in the Dickey collection. Specimen No. H959 in the latter collection, for example, is smaller throughout, in spite of the fact that it is a very old female with cranial sutures completely obliterated and with very well-worn teeth. Compared to *M. o. holzneri*, No. 32.3 of the Santa Barbara Museum collection is also larger throughout. The auditory and mastoid bullæ are more inflated, although this difference is less pronounced; the brain-case is flatter; and the external nares narrower. The ratio of the anteroposterior diameter to the transverse diameter in M1 is less than in No. H959. This is also the case when comparison is made between the Carpinteria form and *M. o. occidentalis*.

Thus specimen No. 32.3 approaches *M. o. occidentalis* in size, but differs from this form and approaches *M. o. holzneri* in several characters. Certain of the distinctive features seen in No. 32.3 are not so evident or are absent in No. 1279 C.I.T. In the several specimens available from the asphalt, two characters appear to distinguish the fossil type from existing subspecies of western California, namely, (1) anteroposterior shortness of M1 and (2) slenderness of M1 and P4.

Taxidea species

A single calcaneum represents the identifiable remains of a badger in the Carpinteria fauna. This specimen can not be distinguished from Recent calcanea and approximates in size the comparable element in *Taxidea taxus berlandieri*.

Urocyon near cinereoargenteus (Schreber)

Remains indistinguishable from the California gray fox are fairly common in the brea deposits. Unfortunately the material consists for the most part of scattered limb elements. Four incomplete rami are also present, two of which belong to juvenile individuals. Most of the teeth in these rami are

[1] A. H. Howell, U. S. Dept. Agric., North American Fauna 20, 44, 1901.

missing. Specimen No. 1280 Calif. Inst. Tech. Coll. Vert. Pale., a left ramus, bears $P\bar{2}$ and an incomplete $P\bar{3}$. Specimen No. 1281 Calif. Inst. Tech. Coll. Vert. Pale., also a left ramus, has $P\bar{2}$ and $P\bar{3}$ in place. Specimens Nos. 1282 and 1283 Calif. Inst. Tech. Coll. Vert. Pale. are rami of juvenile individuals, each bearing $Dp\bar{3}$. In addition, an isolated lower milk carnassial is evidently to be referred to the fox.

Existing foxes of the genus *Urocyon* in the Californian region include the characteristic species of the Channel Islands, and the mainland race *Urocyon cinereoargenteus californicus*. The island forms are all noticeably smaller than the mainland species if comparisons are made between individuals of the same sex. The Carpinteria specimen No. 1280, the larger of the two adults, compares favorably in size with fully adult males of *U. c. californicus*. The smaller ramus, No. 1281, is comparable in size to a fully adult female or possibly a small male of the mainland form. This specimen is similar in size to adult males of the island species. The presence of the larger ramus suggests, however, that the species occurring in the asphalt is related to *U. cinereoargenteus*.

Canis species

The material referred to this genus includes a right ramus with $M\bar{2}$, No. 32.4 Santa Barbara Mus. Pale. Coll., of a coyote and various limb elements which may belong to either coyote or wolf. A definite determination of the latter remains is at present not practicable because of the immaturity of the bones.

Comparative measurements (in millimeters)

	Canis sp. No. 32.4 S. B. Mus. Carpinteria Pleistocene	*Canis ochropus* No. 13789 ♂ Dickey Coll. Recent	*Canis l. lestes* No. 14576 ♂ Dickey Coll. Recent
$M\bar{3}$–$P\bar{1}$, alveolar length	82.5	75.1	80.9
$M\bar{1}$–$M\bar{3}$, alveolar length	39.6	33.8	36.9
$P\bar{1}$–$P\bar{4}$, alveolar length	42.5	41.2	43.8
$M\bar{1}$, alveolar length	24.2	19.9	21.3
Length of diastema between $P\bar{1}$ and $\bar{C}$	2.0	7.0	6.1
$M\bar{2}$, anteroposterior diameter	10.5	9.8	10.8
$M\bar{2}$, transverse diameter	7.1	6.8	7.3

The ramus differs from that of *Canis ochropus*, the California Valley coyote, in slightly larger size, in the more crowded position of the premolars, and in the considerably longer carnassial as indicated by comparative measurements of the alveolus of $M\bar{1}$. The metaconid of $M\bar{2}$ is more pronounced in the Carpinteria specimen but this character is doubtless attributable to the unworn state of the crown of this tooth. The premolars of No. 32.4 are more crowded than in *Canis ochropus orcutti* from Rancho La Brea.

In the characters enumerated, No. 32.4 resembles *Canis latrans*. The only subspecies of *C. latrans* available for comparison, *Canis latrans lestes*, is intermediate in character between *Canis ochropus* and No. 32.4. However, *C. l. lestes* is not so large as typical *C. latrans*, and the carnassial and premolar teeth are smaller and less swollen. While *C. latrans latrans* may approach the Carpinteria specimen rather closely, specific identification of the latter form is hardly warranted on the basis of material available.

Although the limb elements of *Canis* from the Carpinteria deposits can not be specifically determined because of their immaturity, the larger number

of these specimens appear to represent the coyote. The limb elements likewise indicate a slightly larger form than *Canis ochropus.*

An immature ulna, No. 1284 Calif. Inst. Tech. Coll. Vert. Pale., is somewhat larger than the comparable element in a fully adult male individual of *Canis ochropus.* This specimen may belong to a timber wolf. Two radii are very doubtfully referred to the same form or to a large coyote. Unfortunately no skeletons of young wolves are available for comparisons.

Ænocyon near dirus (Leidy)

Three specimens have been recognized as belonging to the dire wolf. Specimen No. 1285 Calif. Inst. Tech. Coll. Vert. Pale. represents a portion of a maxillary bearing Dp3 and Dp4. Specimen No. 1276 Calif. Inst. Tech. Coll. Vert. Pale. is a fifth metacarpal with distal epiphysis missing.

Specimen No. 1285 compares favorably with figures of the milk dentition of *Ænocyon dirus* (U. C. 10831) from Rancho La Brea given by Merriam.[1]

Comparative measurements (in millimeters)

	No. 1285 C.I.T. Carpinteria	No. 10831* Univ. Calif. Rancho L. Brea
Dm3, greatest anteropost. diam.	14.8	14.6
Dm4, greatest anteropost. diam.	10.8	10.8
Dm4, greatest transverse diam.	12.1	11.4

* Measurements after Merriam.

Specimen No. 1286, although representing an individual which is not yet fully grown, compares favorably with *Ænocyon dirus* material from Rancho La Brea.

An additional specimen of the dire wolf in the collections of the Santa Barbara Museum, a fragment of maxillary bearing Dm2 to Dm4, furnished the basis for the determination of this form in the preliminary report on the Carpinteria occurrence.

Felis probably atrox Leidy

A fragment of ramus with milk carnassial, No. 1287 Calif. Inst. Tech. Coll. Vert. Pale., represents a cat which appears to be larger than either *Felis concolor* or *Felis onca.* No. 1287 compares favorably with the comparable milk tooth of *Felis leo* in size, and for this reason the Carpinteria specimen is tentatively referred to *Felis atrox* Leidy. A poorly preserved astragalus of an immature individual is tentatively determined as belonging to the Felidæ. The element is considerably larger than the comparable bone in the wildcat, but probably is not to be referred to the larger felid represented by the jaw fragment.

Lynx species

Two immature calcanea and an astragalus have been assigned to this genus. The astragalus is slightly larger than comparable specimens of *Lynx rufa californicus.* The calcanea are only slightly larger than the comparable element in an adult male domestic cat. However, since the specimens are not fully developed, they have been assigned tentatively to the wildcat.

[1] J. C. Merriam, Mem. Univ. Calif., vol. 1, 233, figs. 12–13, 1912.

RODENTIA

Eutamius species

Several lower jaws and portions of palates establish the presence of the chipmunk. Characters in the dentition clearly indicate that the genus represented is *Eutamius*. The Eastern Chipmunk *Tamius* is at present so far removed in range from the Carpinteria locality as to further preclude the possibility of generic reference other than to *Eutamius*.

On the basis of size and of geographical distribution, the fossil species should apparently be assigned to the *townsendii* group. The subspecies inhabiting the Carpinteria region today is *Eutamius merriami merriami*. Whether the fossil form is to be included in this living species and subspecies can not be satisfactorily determined in view of the range in variation exhibited in the subspecies itself. Skull and jaws of an adult female in the Dickey collection, collected in a Recent fauna at Carpinteria, exhibit characters which are identical with those shown by the Pleistocene form except for slight differences due to varying amounts of wear. Careful examination of numerous specimens of the subspecies *Eutamius merriami merriami* demonstrates a marked variation in certain features of the dentition of this form and eliminates slight differences which might be regarded as of specific or sub-specific value.

Owing to the incompleteness of the fossil material and the minute morphological differences which distinguish the skulls and teeth of living chipmunks, it seems inadvisable to carry the identification of the Pleistocene type beyond the genus.

Sciurus species

The tree-squirrel *Sciurus* is represented in the Carpinteria assemblage by only two isolated teeth, $P\overline{4}$ and $M\overline{1}$?. These specimens agree in size and structure with comparable teeth in Recent specimens of *Sciurus griseus anthonyi* from Santa Barbara County. The teeth are low-crowned and with little or no elevation of the trigonid portion of the crown. The two anterior cusps of $P\overline{4}$ are situated close together, and their position gives a triangular shape to this tooth which is characteristic of *Sciurus*, *Otospermophilus* and *Ammospermophilus*. The California ground-squirrel *Otospermophilus beecheyi* approaches the fossil form in size, but is distinguished from it by slightly higher cusps and by the development of a distinct protoconid-hypoconid ridge.

Thomomys near bottæ (Eydoux and Gervais)

Specimens of the gopher *Thomomys* consist of numerous lower jaws, portions of the premaxillæ bearing the incisors, and the anterior portion of a skull with the complete upper dentition.

In the fossil specimens, the posterior enamel plate of the upper premolar is complete. The last upper molar has only two enamel plates, an anterior and a posterior one. The posterior enamel plate is present and complete on the first, second and third upper molars. Two enamel plates are also present on each of the lower molars. These characters identify the fossil form as *Thomomys*.

Comparison of the material with Recent species shows that the form from the Carpinteria asphalt is a representative of the heavy rostrum group which includes among others the following types; *T. bulbivorus*, *T. townsendi*,

T. bottæ, T. alpinus, T. perpallidus, T. fulvus, T. umbrinus. The following distinctive characters can be observed in the skull of the fossil form:

1. Heavy rostrum
2. Upper incisors with very obscure groove, which may be absent in some specimens
3. Incisors slightly projecting
4. Large size
5. Nasals apparently spatulate.

In view of the enumerated characters, the fossil material has been compared with *T. bottæ*. This species has a very wide distribution at the present time and if *leucodon* is accepted as one of its sub-species, its distribution was equally wide during the Pleistocene. No specific characters in the fossil material serve to distinguish the asphalt species from Recent *T. bottæ*. The two forms correspond closely in size. An apparently immature individual from the asphalt is characterized by a skull with greater dorso-ventral diameter than in any Recent *T. bottæ* of comparable age. The skull characters of gophers vary so greatly with age that the difference noted above can hardly be regarded as sufficient evidence to distinguish specifically the fossil from the Recent type.

Until more material becomes available the gophers of the Carpinteria asphalt are referred, therefore, to *Thomomys bottæ*.

Perognathus species

The specimens of the pocket-mouse *Perognathus* consist of three rami, of which one retains the fourth premolar while the others are without teeth. The paucity of characters presented by this material does not permit positive specific determination.

The size of the lower jaws are within range of variation of jaws of *Perognathus californicus californicus*, and no characters are present to distinguish the fossil type from this subspecies. The generic determination is all that is advisable for the present.

Dipodomys species

The Carpinteria material comprises chiefly lower jaws, with a few maxillary fragments bearing teeth. The teeth of the kangaroo-rat *Dipodomys* present apparently few noteworthy specific characters, for they possess an extremely simple pattern. The expanded bullæ and mastoids, on which specific identification of skulls is frequently made, are unfortunately lost in the fossil specimens.

The specimens available agree in size with the corresponding structures in *Dipodomys agilis*. This species now lives in the vicinity of Carpinteria. However, no specific determination of the fossil material seems warranted.

Onychomys? species

A single left lower jaw without teeth is the only available material from Carpinteria which probably represents the grasshopper-mouse *Onychomys* in the collection. It is possible to distinguish this jaw from *Peromyscus* on the basis of the well-developed coronoid process as well as by the greater angle at which the ascending ramus meets the alveolar portion of the jaw.

The specimen can be distinguished from the lower jaw of *Reithrodontomys* by the character of the descending process of the ramus. In *Reithrodontomys* this portion of the ramus is bent into a more horizontal position than in *Onychomys* and the extreme edge is twisted upward, leaving a depression. Moreover, the coronoid process is less strongly developed in *Reithrodontomys*.

The ramus represents an individual of rather large size, but in this character the species lies within the range of size of *O. torridus* and within that of the subspecies *O. t. ramona.*

Peromyscus species

Remains of the deer-mouse *Peromyscus* consist of lower jaws, usually without teeth, and two maxillary fragments. One of the latter specimens bears $M\underline{1}$ and $M\underline{2}$ while the other carries only the second molar. Due to the scarcity and incompleteness of the material, no specific determination is made.

The pattern of the teeth is very simple and no accessory tubercles are present on any of the molars. On the basis of the latter character the material from the brea deposits may be referred to the subgenus *Haplomylomys.*

Individuals of the living Carpinteria type, *P. californicus californicus* and its related subspecies *P. c. insignis,* appear to be distinctly larger than the fossil forms. The subspecies *P. c. insignis* in contrast to *P. c. californicus* includes individuals of smaller size, and the fossil forms, although deviating somewhat from the norm in this character, may represent the latter subspecies. The Carpinteria asphalt species resembles also *P. eremicus,* another member of the subgenus *Haplomylomys.* At the present time *P. eremicus* does not range so far north as Carpinteria.

P. eremicus fraterculus is another subspecies exhibiting characters close to those of the fossil form in so far as the material permits of comparison. However, one or two differences are to be noted. In *P. e. fraterculus* the median anterior cusp is characterized, in a fairly unworn tooth, by a small infold. This is entirely absent in the fossil species or is only slightly indicated. This character is noted in some specimens of *P. c. insignis* and is absent in other specimens of the same subspecies.

The fossil specimens show the average angle formed by the anterior border of the ascending ramus and the alveolar border of the mandible to be greater than in Recent individuals of *P. e. fraterculus.* The reliability of this character is open to question.

Possibly two species of *Peromyscus* are present in the Carpinteria beds. Of the subgenera, *Peromyscus* has lower molars on which the accessory tubercles are sometimes poorly developed. Possibly some of the lower jaws found in the asphalt represent this subgenus, although no accessory tubercles can be observed on any of the molars. A representative of the subgenus *Peromyscus,* namely *P. maniculatus gambeli,* is found in the Carpinteria region today.

The Carpinteria fossil types may not represent any existing species of *Peromyscus,* and until better material becomes available there appears to be no special reason for assigning these forms to either a new or to an existing species.

The genus *Reithrodontomys* may be represented in the collection by numerous small jaws known to belong to cricetine rodents. The rami average smaller than those referred to *Peromyscus,* although a line of division based on size is difficult to establish. The specimens agree closely with jaws of *Reithrodontomys megalotis longicauda,* a form which inhabits the region about the Carpinteria deposits at the present time.

The principal character of generic importance in the mandible of *Reithrodontomys* is the shape of the descending process. A statement of the characters of this genus given by A. H. Howell is quoted in part.[1]

[1]A. H. Howell, U. S. Dept. Agric., North American Fauna No. 36, 14, 1914.

"Descending process of mandible a broad flattened plate, strongly inflected inward, the lower portion twisted into a nearly horizontal position and the inner margin raised, leaving a distinct depression in the ramus . . ."

However, certain species of deer-mice belonging to the subgenus *Haplomylomys* show practically the same character. As members of the subgenus *Haplomylomys* are present in the Carpinteria assemblage, this character can be used only tentatively. The character of size appears to be the only one of value in a generic separation. In the present instance, however, the fossil jaws may belong to immature individuals of *Peromyscus*. Further material may show that these jaws belong to harvest mice, but for the present they are tentatively referred to *Peromyscus*.

Among the numerous isolated upper incisors from the deposit none was found which showed the grooved character or possessed a size and shape like that of *Reithrodontomys*.

Neotoma species

The material referred to the wood-rat *Neotoma* consists of one right lower jaw with $M\bar{1}$ and $M\bar{2}$, and several isolated teeth. On the basis of the small amount of material available, an attempt to make more than a generic determination does not appear to be justifiable. Two species of *Neotoma* are found living in the region of Carpinteria today, namely *Neotoma intermedia* of the subgenus *Neotoma* and *Neotoma fuscipes* of the subgenus *Homodontomys*. On the basis of size alone the fossil jaw is closer to *N. fuscipes*. Although differences in tooth pattern separate the three subgenera of *Neotoma* these characters are variable to the extent that a determination of fossil material based exclusively on tooth pattern may be subject to considerable uncertainty.

It is interesting to note that *N. fuscipes* builds houses of sticks some distance above the ground. This habit lends support to the belief that a forest environment prevailed during the period of existence of the Carpinteria Pleistocene fauna.

Microtus californicus (Peale)

The fossil material representing the California meadow-mouse *Microtus californicus* consists of numerous lower jaws, parts of two palates, and some isolated teeth. Evidence for the specific determination is presented by the shape of the incisive foramina and the occlusal pattern of the teeth. The former character can be determined even in fragmentary specimens. On the basis of the occlusal pattern of the teeth, the fossil forms resemble most closely the subspecies *M. c. californicus*.

The latter subspecies does not now inhabit the region of Carpinteria, and its presence in the Pleistocene would substantiate the view that a forest essentially similar to the Monterey forest of today was present in the vicinity of the asphalt deposits during the period of existence of the Pleistocene fauna. Possibly certain elements in the mammalian assemblage may have enjoyed a more extended range south of Monterey than is the case at the present time.

The Carpinteria asphalt species has one peculiar character that none of the Recent subspecies possesses. The first internal re-entrant angle of $M\underline{1}$ is wider than in the living species. This character of width is apparently not due to wear. The character does not warrant subspecific separation, for only two specimens of the first upper molar are available in the collection, a number certainly insufficient to demonstrate that the widely re-entrant angle is constant.

LAGOMORPHA

Lepus near californicus Gray

A jack-rabbit is represented by a single left ramus, apparently of an old individual. The tooth-row is complete with the exception of $M\bar{3}$. The specimen is evidently referable to the genus *Lepus*, as indicated by the large size and by the presence of a long diastema. $P\bar{3}$ has the shape and pattern seen in the existing species.

No difference of structure can be observed between the fossil specimen and *L. californicus*. The diastema seems long for the size of the individual, but the length is an extremely variable character and apparently has been duplicated in some of the Recent specimens of *L. californicus*.

The specimen is referred to *L. californicus* which it resembles in size. Jaws of *L. washingtonii klamathensis* are smaller and those of *L. campestris sierræ* are much larger than the Carpinteria specimen.

Sylvilagus bachmani (Waterhouse)

Remains of *Sylvilagus* from Carpinteria are very fragmentary. The collection comprises several lower jaws, portions of the maxillæ and isolated teeth. In size and length of diastema between $\bar{1}$ and $P\bar{3}$, these specimens are distinctly more like *Sylvilagus* than like *Lepus*.

Two of the species of *Sylvilagus*, *S. bachmani* and *S. audubonii*, are distinguished by their size. The former type is smaller than the latter and is further characterized by the straight anterior wall of the posterior re-entrant angle of $P\bar{3}$ and by the less complex folds in the re-entrant angles of $M\underline{1}$ and $M\underline{2}$. A large number of specimens from the Carpinteria Pleistocene possess the characters peculiar to *S. bachmani*.

The collection contains several young specimens and the separation of the two species is made with difficulty. In *S. bachmani* the third lower premolar lacks the plication seen in the posterior re-entrant angle characteristic of *S. audubonii*. The wall of the re-entrant angle in the Carpinteria species is in some cases slightly wavy. A Recent specimen of *S. audubonii* shows a $P\bar{3}$ having this character, although the Recent tooth is more of the plicated type. In this regard it may be indicated that the statement by Dice[1] that in *S. bachmani* the enamel is straight or in rare instances simply crenulated can not be verified. Recent specimens of *S. bachmani* have been found in which definite plications exist.

The first and second upper molars of the fossil material correspond in pattern to those of the Recent *S. bachmani*. One specimen from the asphalt having a size larger than the average may represent *S. audubonii*. Here again the statement by Dice[2] that, "The enamel of the anterior edge of the re-entrant angles of the first and second upper molars seems never to be more than slightly wavy in the *S. bachmani* group, and is usually a nearly straight line," is not supported by all specimens. Several specimens of the Recent *S. bachmani* are available in which the folding on these teeth can hardly be regarded as only slightly wavy.

In size the fossil specimens are all small and fall readily within the species *S. bachmani*. The presence of *S. audubonii* is not certainly indicated. However, a right maxillary with $P\underline{3}$, $P\underline{4}$, $M\underline{1}$ and $M\underline{2}$ is characterized by large size and by very well-developed plications on the re-entrant angle of

[1] L. R. Dice, Carnegie Inst. Wash. Pub. No. 349, Art. VII, 128, 1925.
[2] L. R. Dice, *ibid.*, 129, 1925.

M2. In this specimen the enamel forming the re-entrant angle of M2 is more complicated than that forming the angle of M1.

The morphological characters possessed by the *Sylvilagus* specimens from the Carpinteria deposit, in the light of structural features of the dentition in existing species of this genus, indicate definitely that the former types are to be referred to *Sylvilagus bachmani*. The presence of *S. audubonii* can not be definitely shown, but the sharp distinctions in enamel pattern between this species and *S. bachmani* are not maintained, as shown by the comparisons made in the present study.

ARTIODACTYLA

Camelops? cf. hesternus (Leidy)

A single lumbar vertebra, No. 32.6, Santa Barbara Mus. Pale. Coll., of a large ungulate resembles in size the comparable vertebræ in *Camelops* and *Bison*. The specimen differs more from *Bison antiquus* than from *Camelops hesternus* in this character. No. 32.6 likewise resembles the latter and differs from the former in depth of centrum and in absence of a ventral keel. Unfortunately the specimen lacks for the most part the neural spine and the transverse processes are likewise largely broken away. The articulating surface of the anterior zygapophysis is deeply cupped.

Odocoileus species

A maxillary fragment with Dp3, Dp4, M1 and M2, a ramus with Dp4, two isolated teeth, Dp4? and M1?, and fragmentary remains of limb elements have been referred to this genus.

The maxillary fragment, No. 32.5 Santa Barbara Mus. Pale. Coll., is comparable, in so far as can be determined, to specimens of *O. hemionus*. Unfortunately a maxillary of *O. hemionus* in a similar stage of development is not available for comparison. A specimen of *O. columbianus scaphiotus* (Dickey Coll. No. 14,389) presents a stage of tooth wear comparable to that in No. 32.5. Comparisons show the Carpinteria specimen to be larger and to have less development of the internal basal cuspule in M1 and M2. The metacone rib in No. 32.5 is only faintly marked if at all developed in the permanent molars.

Much of the limb material represents the remains of young individuals and is too poorly preserved to be accurately determined. However, a distal end of a humerus, a proximal end of an ulna, a distal epiphysis of a femur, two calcanea, and a navicular-cuboid possess enough character to assure reference to the genus *Odocoileus*. It should be stated that because of the fragmentary and immature state of much of the material, the reference of at least some of the specimens to *Antilocapra* can not be wholly eliminated.

Bison? species

A large navicular-cuboid, No. 1294, Calif. Inst. Tech. Coll. Vert. Pale., of a young individual may represent a bison. This specimen is too large to permit reference to the deer or antelope, and differs rather distinctly in several characters from the corresponding element of the genus *Cervus*.

In No. 1294 the posterior part of the calcanear facet is like that in *Bison antiquus* in not ascending sharply to a distinct process as is the case in *Cervus*. No. 1294 also agrees with *Bison antiquus* in having the metatarsal facet nearly horizontal. In *Cervus* the facet is inclined from the horizontal, the anterior portion being depressed. Furthermore, No. 1294 corresponds to the navic-

ular-cuboid of *Bison* in lacking the depth seen in that element in *Cervus*. Although the navicular-cuboid of *Cervus* is distinctly smaller than in *Bison*, the actual depth is not much less.

On the other hand, No. 1294 agrees more closely in size with the corresponding element in *Cervus* than it does with one of the smaller specimens of the navicular-cuboid of *Bison antiquus* from Rancho La Brea available in the large collections of the Los Angeles Museum. No. 1294 differs from both *Bison* and *Cervus* in the extreme shallowness of the transverse depression between the external cuneiform facet and the transverse facet for articulation with the metatarsal element. However, this character may be due to the immature character of the specimen.

PERISSODACTYLA

Equus near occidentalis Leidy

The horse material from the Carpinteria asphalt is limited to limb elements. A metatarsal, proximal fragment of femur, calcaneum, astragalus, first phalanx, ungual phalanx, and fragments of a sacrum and pelvis represent the adult material at hand. The limb elements are comparable in size to specimens of *Equus occidentalis* and probably represent that species. Specimens of *Equus occidentalis* from Rancho La Brea and McKittrick show considerable variation in size and a larger collection is necessary to determine the Carpinteria material accurately. In character of size the Carpinteria specimens make apparently a closer approach to *E. occidentalis* than to *E. pacificus*.